

REMARKS

The Office Action dated August 10, 2009 has been reviewed, and reconsideration of the application and allowance thereof are requested based on the following remarks.

Claims 10-12, 14-18, 20, 24-26 and 28 have been rejected under 35 U.S.C. §101 because the claimed invention is directed to non-statutory subject matter. Independent Claims 10, 15 and 24 have been amended by adding a new component, "a display," as recommended by the Examiner. Claims 11, 12, 14, 16-18, 20, 25, 26 and 28 depend upon allowable Claims 10, 15 and 24, respectively.

Claims 1, 5, 10, 14, 19-21, 24, 27 and 28 stand rejected under 35 USC §103(a) as being unpatentable over Redshaw et al., GB Patent 2 343 603 in view of McNamara et al., U.S. Publication No. 2003/0122829 and in further view of Steiner et al., U.S. Patent No. 5 668 940.

Claim 1 of the present invention is directed to a tiling method for culling small objects in a system for shading 3-dimensional computer graphics images, comprising the steps of:

subdividing a display on which an image is to be viewed into a plurality of rectangular areas;

deriving a list of objects in the image which may be visible in each of the rectangular areas;

determining maximum and minimum values for each object in the list in x and y directions;

determining a minimum set of sampling points for the object from the maximum and the minimum values;

surrounding the object with a bounding box;

determining if the bounding box covers any of the sampling points;

culling the object if the bounding box misses all of the sampling points;

testing each of the sampling points in the minimum set against each edge of the object if the bounding box does not miss all of the sampling points; and

culling the object in the system for shading 3-dimensional computer graphics if the object does not cover any of the sampling points. (emphasis added)

In contrast, Redshaw teaches a method for shading 3-dimensional computer generated images, comprising the steps of:

representing each object in the image as a set of polygons;

dividing the image plane on which the image is to be displayed into a plurality of rectangular areas;

supplying data defining the location of each polygon;

determining which rectangular areas are required to show the whole of the polygon;

for each pixel in each rectangular area, determining a depth value for the distance of a surface of the polygon from the image plane, determining whether the surface is visible at that pixel, and shading the pixel in dependence on the result of the determination.

Specifically, Redshaw is concerned with minimizing the total number of tiles or rectangular areas which will require processing. In this regard, Redshaw teaches, at page 7, lines 34-36 through page 8, lines 1-11, that it is only necessary to process the objects which intersect with a particular region or area (i.e. a tile). A triangle is utilized to represent the vertices of the object, and a bounding box is generated from this triangle and effectively defines a rectangular area within the screen which contains the object. The bounding box for the object is utilized to obtain a list of tiles located within the bounding box. This list of tiles is a subset of all the tiles within the screen and approximates the tiles which intersect with the object. Redshaw is thus concerned with determining a minimal set of tiles with which the triangle representing the object to be rendered crosses, and then only processes those tiles when rendering the object so as to improve processing efficiency. Thus, the purpose of the

invention disclosed in Redshaw is to reject tiles which are not necessary for rendering the object.

Redshaw is also concerned about determining which surfaces intersect particular rectangular areas within an image and improving processing efficiency by processing only surfaces which intersect a particular rectangular area for that tile. A tile comprises a plurality of pixels. Thus, once a surface has been determined as being potentially visible within a tile, each pixel in the tile must be processed to determine whether or not the surface is in fact visible at that pixel, irrespective of the size of the surface.

The present invention is concerned about disposing of objects if they are too small to make a significant contribution to the final image. The object list-deriving steps in Claim 1 of the present invention are carried out so that small objects which have no significant impact on the overall scene being rendered are not rendered. The above steps embody a two-stage process which in the first stage will cull the object if a bounding box surrounding the object misses all of the sampling points and, in the second stage, each sampling point is tested against each edge of the object and it is determined whether or not the object covers any sampling point, and then the object is added or rejected from the list as a result of this determination. This is completely different from the purpose of Redshaw's invention, which, as understood, is not concerned with rejecting objects from an object list corresponding to a rectangular area or tile and therefore avoiding having to render these objects as is the case with the instant invention, and instead is concerned with rejecting tiles which do not intersect with the object so as to avoid having to process these tiles at all.

As for the step of deriving the list of the objects in the image which may be visible, Redshaw discloses in page 2,

lines 21-23 that a display list of the surfaces which fall in that tile is used to define objects within the bounding box. Thus, Redshaw teaches the display list of the surfaces rather than the visible object list.

As for the step of determining maximum and minimum values, Redshaw disclose in Figures 6-10 various examples of different triangles with different bounding boxes, and different numbers of tiles required to display them, rather than teaching the calculation for the maximum and the minimum values for the objects. Thus, Redshaw teaches selecting a set of tiles based upon the maximum and minimum values of the object while the present invention culls the object if the bounding box misses all of the sampling points for the object. The bounding box determined from the maximum and minimum values of the x and y coordinates of the object may miss a standard set of the sampling points for the pixels when the object is small.

The Examiner states that Redshaw does not explicitly teach the remaining steps, and cites McNamara and Steiner so as to allegedly cure the deficiencies.

McNamara is concerned about the efficient movement of a rectangular sample stamp to all sample points which a polygon covers for rasterization purposes in order to avoid unnecessary stamp positions containing no sample point inside the polygon. The object in McNamara is to capture all the objects rather than to reject them. The method of McNamara would be used in an immediate mode rendering that contains all of the polygons in a single display, while the present invention uses the tiling method to put the polygons in the display lists for each tile.

As for the step of determining the minimum set of sampling points for the object from the maximum and the minimum values, McNamara discloses in Figure 7 and in paragraph [0079] that unproductive positions provide a path to

more distant stamp positions which generates fragments 710 contained in the triangle 700. However, McNamara does not teach determining the minimum set of the sampling points for the object.

As for the step of determining if the bounding box covers any of the sampling points, McNamara discloses in paragraph [0127] that step 1701 determines the minimal rectangular bounding box that encloses the object rather than the sampling points.

As for the step of culling the object if the bounding box misses all of the sampling points, McNamara discloses in paragraph [0212] that if the sparse context over or the saved context overSave is valid, then there is no point in moving to any sliver back and forward positions. However, McNamara does not teach selecting the object.

Steiner's method removes small polygons. In column 13, line 55-column 14, line 2, Steiner discloses that small polygons can be detected and filtered to reduce scintillation, and that to do this, each of the four corners of the present pixel is considered independently. As shown in Figure 5e, the filter for the small polygon counts the number of intersection points between polygon edges and the four sides of the pixel, and then decides which blending function to use for the pixel color from one of the seven cases shown in Figures 8a-8g. Thus, Steiner's method calculates a pixel shading color by looking at the sub-pixel level to determine the blend of color from polygons that cover only part of the pixel. However, the Steiner reference does not describe how to remove the small objects from a display list that do not cover any pixel sample point.

In contrast, the method of the present invention works at the pixel resolution to remove the whole object from the display list if the object does not cover any pixel sample point.

Further, the combination of the cited prior arts is improper. McNamara uses a movable rectangular sample stamp in order to sample all the points which the polygon covers and thus does not reject the small polygons, while Steiner uses the contribution from the small polygons to determine the pixel color to use. In contrast, Redshaw determines the bounding box based on the units of the tiles rather than the small polygons, which is different from the method of the present invention where the bounding box is determined purely in terms of the extent of an object in the x and y directions so that the determination can be made as to whether the bounding box covers any pixel sampling points.

Accordingly, Claim 1 is believed to be patentably distinguishable over Redshaw, McNamara and Steiner, alone or in combination with one another.

Claims 5 and 19 depend upon what is believed to be an allowable Claim 1, are believed allowable therewith, and include additional features which further distinguish over Redshaw, McNamara and Steiner. For example, Claim 5 includes the step of, for each of the objects, selecting only those rectangular areas which fall at least partially within the bounding box of the object when determining whether or not that object is to be added to the list for the rectangular area. Redshaw does not teach the selection of the rectangular areas.

Claim 19 includes the step of determining whether or not the minimum set of the sampling points are spread by more than 2 x 2 pixels in the x and the y directions, wherein the step of testing the sampling points is not performed if the sampling points exceed this limit. McNamara discloses in paragraph [0009] the stamp rectangle which is 2<sup>m</sup> pixels wide by 2<sup>n</sup> pixels high, rather than the sampling points of 2 x 2 pixels.

Claims 10, 14 and 20 are directed to an apparatus corresponding to the method of Claims 1, 5 and 19, respectively, and therefore Claims 10, 14 and 20 are believed to be allowable over Redshaw, McNamara and Steiner for the same reasons as presented above relative to Claims 1, 5 and 19.

Claims 21 and 24 includes the similar steps as disclosed in Claims 1 and 10, respectively, and therefore are believed to be allowable over the cited references for the same reasons as presented above relative to Claims 1 and 10. Claims 21 and 24 clarify that the culling of the objects is not restricted to images which are divided into a plurality of the rectangular areas. The invention disclosed in Claims 21 and 24 can also be used on an untiled image or as a pre-tiling stage to dispose of the smaller objects before the tiling begins.

Claims 27 and 28 depend upon what is believed to be allowable Claims 21 or 24, and are believed allowable therewith.

Claims 6, 7, 15 and 16 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Redshaw in view of Pearce et al., U.S. Patent No. 5 809 219.

Claim 6 is directed to a tiling method for shading 3-dimensional computer graphics images in a system for shading 3-dimensional computer graphics images comprising the steps of:

subdividing a display for each of the images into a plurality of rectangular areas;

for each object in the image, determining a bounding box of the rectangular areas into which the object may fall;

testing an edge information from each object against a consistent sample point in each of the rectangular areas to determine whether or not the object falls into each of the rectangular areas in the bounding box; and

inserting the object in an object list for the rectangular area based of a result of the determination,

wherein the step of testing the edge information comprises the step of shifting the edge information by a predetermined amount based on an orientation of each edge. (emphasis added)

As for the step of determining the bounding box of the rectangular areas, Redshaw discloses in page 8, lines 7-11 that a bounding box for a particular object can be aligned to tile boundaries so that a list of tiles within the bounding box can then be obtained. However, Redshaw does not teach the bounding box of the rectangular areas. Instead, Redshaw teaches the bounding box for the object itself.

With respect to the step of inserting the object in the object list for a rectangular area, the Examiner points to Redshaw at page 13, lines 28-31, which read "[f]or each edge of the triangle, each tile in the rectangular bounding box must be processed in this way to decide whether or not it should be excluded from the minimal set." As discussed above with respect to Claim 1, this passage, contrary to the Examiner's interpretation, pertains to the exclusion of a tile from a minimal set of tiles which should undergo processing, and not to any step which pertains to determining whether an object should be inserted in an object list for a rectangular area or tile, as recited in Claim 6.

As for the step of shifting the edge information by a predetermined amount, the Examiner points to Redshaw at page 13, lines 23-27, which read "[t]he comparison of the two values will indicate whether the point lies on the inside or outside of the edge. The interpretation of this result depends on the orientation of the edge as given in the table in Figure 9." The Examiner further explains that simpler mathematical operations would be achieved by shifting by a predetermined amount. However, at page 13, lines 28-31, Redshaw discloses that for each edge of the triangle, each tile in the rectangular bounding box, (not edge information from each object), is processed to decide whether or not the tile (not the object) should be excluded from the minimum set.



The Examiner states that Redshaw does not teach the step of testing the edge information from each object against the consistent sample point, and cites Pearce so as to allegedly cure this deficiency. In this regard, Pearce is directed to a method of simulating motion blur. Pearce, as understood, discloses motion vectors for the vertices in a three-vertex polygon that describe the motion of vertices as the three-vertex polygon moves from an initial to a final position. Pearce teaches a system and a method for simulating motion blur by identifying intersections of pixel sampling points with edges of moving polygons. The edges of the polygons of Pearce are moving as the polygons are moving, and thus Pearce does not pertain to shifting edge information of an object by a predetermined amount. On the contrary, the shifting step of Claim 6 is designed to allow the use of a consistent test corner for all edges rather than moving the test point as a function of the edge, which results in lower cost implementations.

It is accordingly submitted that the invention taught in Pearce, as described above, is concerned with stationary sampling points with respect to moving polygons in order to produce a temporary anti-aliased motion blurred result. On the contrary, Claim 6 teaches testing edge information from each object against a consistent sample point, which testing includes shifting the edge information of the object depending on the orientation of each edge, so as to determine whether or not the object falls into each of the rectangular areas in the bounding box.

The Examiner explains that simplified mathematics is achieved by having a stationary sampling point rather than one that moves. The present invention uses the shifting step to achieve a safe calculation rather than to simplify the mathematics, as taught in the specification. Redshaw uses the expression of " $y \text{ op } mx+c$ ", (where op is either less than or

greater than), which differs from that used in the present invention, in that Redshaw requires additional special case testing for vertical edges where "m" approaches infinity. The present invention does not require such special case testing. The shifting of the present invention decreases the complexity of the hardware, for example, through removal of requirements for additional decisions made on a per-tile/per-edge basis. The present invention also allows for implementations using imprecise, that is, floating point mathematics to produce safe results. On the contrary, Redshaw as understood would require fully accurate mathematics in order not to accidentally leave some polygons out of tiles.

Furthermore, while Pearce teaches sampling an individual pixel against a triangle that is moving over a period of time in order to produce a temporally anti-aliased motion blurred result, it will be appreciated that the present invention does not have the edges moving through time. Instead, the edges of the triangle are adjusted only once during an initiation phase with the amount of adjustment depending on the orientation of the edge. Then, a sampling of the shift triangle at the corner of the tiles determines whether the original triangle has any intersection with a tile.

Pearce particularly teaches the consistent sample point in each rectangular area whilst the claim requires shifting of the sample point. Redshaw teaches the use of a fixed sample point in relation to an edge rather than a shifting sample point. Thus, the combination is not proper.

As such, even if, for the sake of argument, the steps of Pearce pointed out by the Examiner were somehow combined with Redshaw, this would not result in a method which determines whether objects should be inserted in an object list for a rectangular area, as recited in Claim 6, since neither reference is directed to this feature. As such, the combination of Redshaw and Pearce is not believed to result in

the instant invention as defined in Claim 6, and thus the combination is believed improper.

Accordingly, Claim 6 is believed to be patentably distinguishable over Redshaw and Pearce, alone or in combination with one another.

Claim 7 depends upon what is believed to be an allowable Claim 6, is believed allowable therewith, and includes additional features which further distinguish over Redshaw and Pearce. Claim 7 further discloses that the step of shifting the edge information comprises the step of shifting by either a vertical or a horizontal dimension of the rectangular area." Pearce discloses in column 4, lines 57-59 that one or more polygons on object are matched to the x, y coordinates of sample points. Pearce's motion vectors do not shift edge information or specifically shift the dimension of a rectangular area. Further, Pearce illustrates a two-dimensional projection into x, y coordinates for the three-dimensional object rather than shift dimensions of a rectangular area.

Claims 15 and 16 are directed to an apparatus corresponding to the method of Claims 6 and 7, respectively, and are believed to be allowable over Redshaw and Pearce, for the same reasons as presented above relative to Claims 6 and 7.

Claims 8 and 17 stand rejected under 35 U.S.C. §103(a) as unpatentable over Redshaw in view of Pearce, and in further view of Vatti et al., U.S. Patent No. 5 265 210. Claims 8 and 17 depend upon what is believed to be allowable Claims 6 and 15, respectively, and are believed allowable therewith.

Claim 8 recites that the shifting step is performed using a floating point calculation, and Claim 17 recites means for performing the step of Claim 8. While the present invention teaches that the shifting the edge information is performed with a floating point comparison, Vatti teaches the floating point addition of the values to the coordinates of the address of the just-plotted pixel. As such, Claims 8 and 17 are

believed to be allowable over Redshaw, Pearce, and Vatti, alone or in combination with one another.

Claims 9 and 18 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Redshaw in view of Pearce, and in further view of Venkataraman et al., U.S. Publication No. 2002/0180729. Claims 9 and 18 depend upon what is believed to be allowable Claims 6 and 15, respectively, and are believed allowable therewith.

Claim 9 recites that the shifting step is performed with a safety margin whereby objects will be included in object lists for a rectangular area if the edge information falls close to a sampling point. Claim 18 discloses means for performing the step of Claim 9. Venkataraman teaches that the circularity can be tested by picking three points on the cross edge and then checking whether or not the sample points lie on a circle, within a tolerance. The shifting step of the present invention has a safety margin during processing. The Venkataraman invention, on the contrary, checks whether or not the sample points lie on a circle within a tolerance, rather than performing with a safety margin. As such, Claims 9 and 18 are believed to be patentably distinguishable over Redshaw, Pearce, and Venkataraman, alone or in combination with one another.

For the above reasons allowance of the instant application is respectfully requested.

Respectfully submitted,

  
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